

## MINIMUM IDLE AIR RATE 1987 and 1988 Model Year Trucks

| Engine                   | Transmission | Gear (D/N) | Engine Speed (rpm) | Open/Closed Loop ③ |
|--------------------------|--------------|------------|--------------------|--------------------|
| 2.5L                     | Man.         | N          | 600 ± 50           | CL                 |
|                          | Auto.        | N          | 500 ± 50           | CL                 |
| 2.8L                     | Man.         | N          | 700 ± 50           | OL                 |
|                          | Auto.        | N          | 700 ± 50           | OL                 |
| 4.3L                     | Man.         | N          | 450 ± 50           | CL                 |
|                          | Auto.        | D          | 400 ± 50           | CL                 |
|                          | Auto. ①      | N          | 475 ± 50           | CL                 |
| 5.0L                     | Man.         | N          | 500 ± 25           | OL                 |
|                          | Auto.        | D          | 425 ± 25           | OL                 |
|                          | Auto. ②      | D          | 425 ± 25           | CL                 |
| 5.7L<br>(under 8500 GVW) | Man.         | N          | 500 ± 25           | OL                 |
|                          | Auto.        | D          | 425 ± 25           | OL                 |
| 5.7L<br>(over 8500 GVW)  | Man.         | N          | 550 ± 25           | CL                 |
|                          | Auto.        | D          | 450 ± 25           | CL                 |
| 7.4L                     | Man.         | N          | 700 ± 25           | OL                 |
|                          | Auto.        | D          | 700 ± 25           | OL                 |

① 4.3L S series.

② 5.0L without AIR system.

③ Let engine idle until Open/Closed Loop is reached.

pressure. Disconnect the negative battery cable.

2. Disconnect and cap the fuel lines. Disconnect the electrical connector. As required, remove the fuel tank from the vehicle.

3. Remove the fuel pump retaining assembly. Remove the fuel pump from the vehicle.

4. Installation is the reverse of the removal procedure. Be sure to use a new gasket or rubber O-ring, as required.

## EMISSION CONTROLS

- Catalytic converter
- Positive crankcase ventilation (PCV)
- Thermostatic air cleaner (THERMAC)
- Exhaust gas recirculation (EGR)
- Early fuel evaporation (EFE)
- Air injector reactor (AIR)
- Evaporative emission control (EEC)
- Computer command control (CCC)
- Backpressure exhaust gas recirculation

- Emissions calibrated carburetor
- Emissions calibrated distributor
- Charcoal canister
- Canister control valve
- Canister purge thermal vacuum switch
  - Deceleration mixture control valve
  - Deceleration valve
  - EGR backpressure transducer
  - EGR thermal vacuum switch
  - EGR vacuum bleed solenoid
  - EGR solenoid
  - Hot idle compensator
  - Oxidizing catalyst
  - Slow idle fuel cut solenoid
  - Torque converter clutch thermal vacuum switch
  - Transmission converter vacuum switch
  - Transmission converter vacuum delay valve

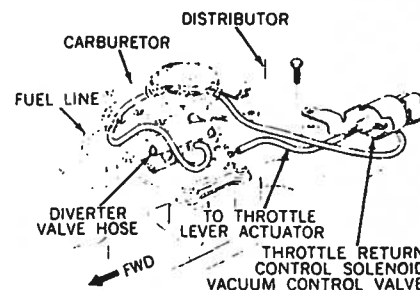
## Positive Crankcase Ventilation System

The positive crankcase ventilation system (PCV) is used on all vehicles to provide a more complete evacuation of the crankcase vapors. Outside vehicle air is routed through the air cleaner to the crankcase. It is then mixed with blow-by gases and is passed through the PCV valve. It is then routed into the intake manifold. The PCV valve

measures the air flow rate which varies under engine operation depending on manifold vacuum. In order to maintain idle quality, the PCV valve limits the air flow when the intake manifold vacuum is high. If abnormal operating conditions occur, the system will allow excessive blow-by gases to back flow through the crankcase vent tube into the air cleaner. These blow-by gases will then be burned by normal combustion.

## REMOVAL & INSTALLATION

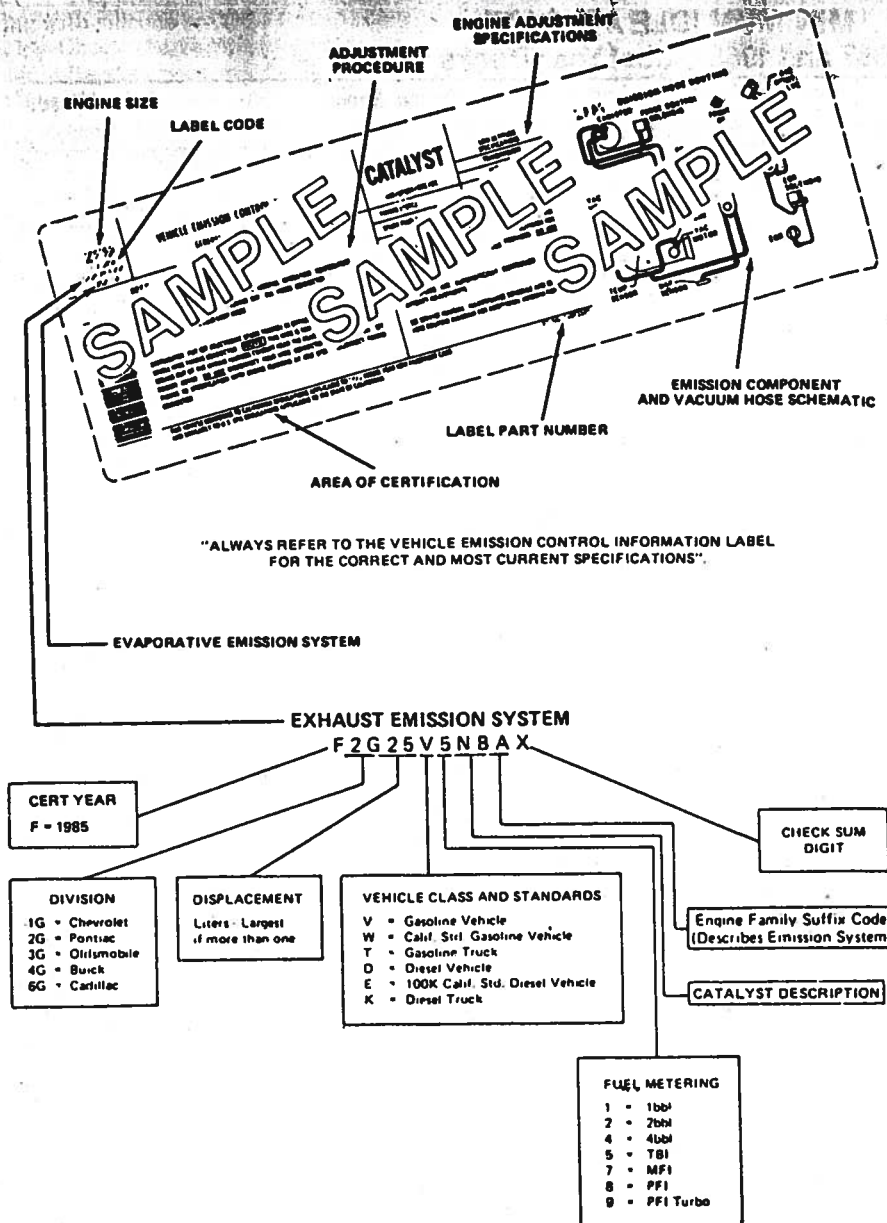
1. Remove the PCV valve from the rocker arm cover.
2. Start the engine and allow it to reach normal operating temperature. Allow the engine to run at idle speed.



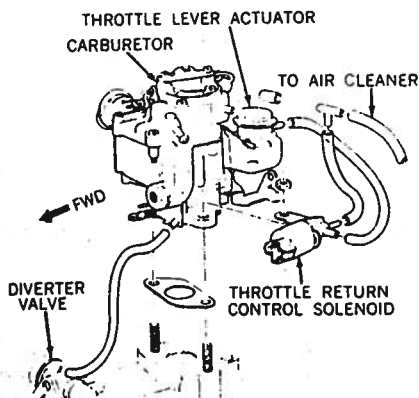
350 CID V8

Location of solenoid vacuum control valve—V8 engines

# 1 CHEVROLET/GMC



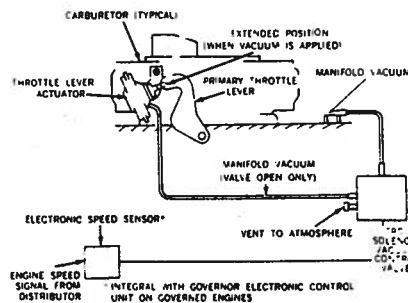
Typical Emission Information label and decoding examples



Location of solenoid vacuum control valve—6 cylinder engine

3. Check for vacuum at the end of the valve. If there is no vacuum at the end of the valve, check for defective hoses or a clogged manifold port.

4. Turn off the engine and remove



Throttle return control system

the PCV valve. Shake the valve and listen for the rattle of the check needle inside the valve. If no rattle is present, replace the valve.

5. Check the systems hoses and clamps and replace any that show signs of deterioration.

## EVAPORATIVE EMISSION CONTROL SYSTEM

The evaporative emission control system is designed to trap fuel vapors emitted from the fuel tank and carburetor during normal engine operation. This will prevent gasoline vapor discharge into the atmosphere. Gasoline vapors are absorbed through the use of a fuel vapor charcoal canister. The charcoal canister absorbs the gasoline vapors and stores them until they can be removed and burned in the engine. The vapors are removed from the charcoal canister by a solenoid operated bowl vent located in the carburetor. In order to accomplish this, the fuel tank requires a non vented fuel cap. A vent located in the fuel tank, high enough above the fuel, will allow the vent to be in fuel vapors all the time. Another vent pipe is connected directly to the charcoal canister, where excess vapor is stored. From the fuel charcoal canister, the vapors are routed to the PCV system. This will allow the vapors to be burned during engine operation.

## Charcoal Canister

This fuel vapor canister is used to store and absorb fuel vapors from the carburetor bowl and fuel tank. The canister purge valve is an integral part of the vapor canister. The valve consists of a housing and tube molded into the canister cover, valve assembly, diaphragm, diaphragm and valve spring. The diaphragm cover has a built in control vacuum signal tube.

While the engine is idling, spring tension holds the purge valve closed. Only a small amount of fuel vapor can be drawn from the canister. This is accomplished through a small calibrated constant bleed hole which leads from the charcoal to the tube marked PCV. This will allow purge of the canister through the PCV hose during engine idle. A replaceable filter is used on the bottom of the canister which prevents contaminants from entering the charcoal canister. Part of normal servicing requires that the filter element be replaced.



## Auxiliary Vapor Canister

Vehicles equipped with dual fuel tanks are also equipped with an auxiliary fuel vapor canister. It is added to the primary canister. On the bottom of the auxiliary canister is a hose which connects to the primary canister's purge air inlet.

Vapor overflowing from the primary canister is stored in the auxiliary canister. During the purge, vapor flows through the auxiliary canister, the primary canister and into the intake manifold for burning during combustion.

### SYSTEM TEST

1. Apply a length of hose to the PCV tube of the purge valve assembly (lower tube), and try to blow air through it. Little or no air should pass into the charcoal canister.

**NOTE:** If the vehicle is equipped with constant purge, a small amount of air will pass into the canister.

2. Using a vacuum pump, apply vacuum (15 in. Hg. or 51 kPa) through the control vacuum signal tube to the purge valve diaphragm. If the diaphragm does not hold vacuum for at least 20 seconds the diaphragm is leaking. Replace the charcoal canister.

3. If the diaphragm holds vacuum, attempt to blow air through the hose connected to the PCV tube while vacuum is still being applied. An increase of air should be observed. If no air increase is noted, the charcoal canister must be replaced.

### REMOVAL & INSTALLATION

1. Disconnect the negative battery cable.

2. Remove the necessary components in order to gain access to the charcoal canister.

3. Tag and disconnect the hoses from the canister.

4. Remove the charcoal canister retaining nut.

5. Remove the canister from the vehicle.

6. Installation is the reverse of the removal procedure. Refer to the vehicle emission control label, located in the engine compartment for proper routing of the vacuum hoses.

## Auxiliary Vapor Canister

### REMOVAL & INSTALLATION

1. Disconnect the negative battery cable.

2. Tag and disconnect the hoses from the auxiliary canister.

3. Remove the retaining screw from the auxiliary canister bracket.

4. Remove the canister from the vehicle.

5. Installation is the reverse of the removal procedure.

## Exhaust Emission Control System

### Thermostatic Air Cleaner

Fresh air supplied to the air cleaner comes either from the normal snorkel, or a tube which is connected to the exhaust manifold. A door in the snorkel regulates the source of incoming air so that the engine always takes in warm air. The snorkel door may be controlled in a number of ways, but most are vacuum operated. The vacuum operated models use a thermostatic bi-metal switch inside the air cleaner that bleeds off vacuum as the engine warms up, and regulates the position of the air door. On certain vehicles, the snorkel is connected to a tube which is routed to the front of the vehicle in order to take in cooler air from outside the engine compartment. A vacuum diaphragm motor, which is built into the air cleaner snorkel, moves the damper door to admit hot air from the exhaust manifold, outside air or a combination of both.

A temperature sensor, located inside the air cleaner reacts to air intake temperature and controls the amount of vacuum the engine receives. When the outside temperature is below approximately 86°F (30°C), the sensor allows vacuum to the motor and the damper door will shut off outside air to the engine, allowing only heated air from the exhaust manifold to enter the air cleaner.

When the temperature is above 131°F (55°C), the damper door opens allowing only outside air to enter the air cleaner. When the outside temperature is between these two readings, the damper door opens partially allowing a combination of outside and heated air to enter the air cleaner. Incorrect TAC operation can result in warm up hesitation, lack of power or sluggishness on a hot engine.

### SYSTEM SERVICE

1. Inspect the system to verify that all hoses and heat tube are connected properly. Inspect for kinked or rotted hoses.

2. Inspect the air cleaner element for proper gasket seal.

3. When the air cleaner assembly is installed, the damper door should be open.

4. Start the engine. When the engine is first started, the damper door should close off any outside air.

5. If the TAC system fails to operate properly perform the vacuum motor check. If the complaint is a drivability problem, perform the temperature sensor check.

#### Temperature Sensor

1. The test must be performed with the air cleaner temperature below 86°F (30°C). If the engine is warm, place a temperature sensing probe as close as possible to the temperature sensor. Allow the engine to cool until it reaches the above temperature.

2. Start the engine and observe the damper door. It should move to close off any outside air.

3. When the damper door starts to open, remove the air cleaner cover and read the temperature sensing probe. It should read approximately 131°F (55°C). If not, replace the temperature sensor.

### REMOVAL & INSTALLATION

1. Remove the air cleaner assembly from the vehicle.

2. Tag and disconnect the vacuum hoses from the temperature sensor.

3. Reposition the tabs on the temperature sensor retaining clip.

4. Remove the clip and sensor from the air cleaner. Take note of the sensor position for ease of reinstallation.

5. Installation is the reverse of the removal procedure.

#### Vacuum Motor

1. With the engine off, disconnect the vacuum hose at the vacuum diaphragm motor.

2. Apply about 7 in. Hg. of vacuum to the vacuum diaphragm motor. The damper door should completely block the outside air out. If not, check to be sure that the linkage is installed correctly.

3. With vacuum still applied, trap the vacuum in the vacuum diaphragm motor assembly by bending the hose. The damper door should remain closed, if not replace the vacuum motor assembly.

4. If the vacuum motor proves to be good, check all hoses and connections and if they are good, replace the temperature sensor.



## Catalytic Converter

The catalytic converter is mounted in the engine exhaust stream and works as a gas reactor in which its major function is to speed up the heat producing chemical reaction between the exhaust gas components, in order to reduce the air pollutants in the engine exhaust. The converter produces CO<sub>2</sub> and water when operating. The catalyst material is either a ceramic substance or pellets which are coated with a base of alumina and then impregnated with catalytically active metals. It is the surface of the catalyst material that controls the heat producing chemical reaction.

### SYSTEM SERVICE

1. Raise and support the vehicle safely.
2. Inspect the catalytic converter protector for any damage. If any part of the protector is dented to the extent that it contacts the converter, replace it.
3. Check the heat insulator for adequate clearance between the converter and the heat insulator. Repair or replace any damaged components.

### REMOVAL & INSTALLATION

1. Raise the vehicle and support safely.
2. Making sure that the catalytic converter is cool, remove the air suction pipe.
3. Remove the retaining bolts at the front and the rear of the converter.
4. Remove the catalytic converter from the vehicle.
5. Installation is the reverse of the removal procedure. Lower the vehicle, start the engine and check for exhaust leaks.

## Exhaust Gas Recirculation System

The EGR system is used to reduce the oxide of nitrogen emission levels caused by high combustion temperatures. This is accomplished by reducing the combustion temperatures. The EGR valve is mounted on the intake manifold. It is opened by manifold vacuum to allow exhaust gas to flow into the intake manifold. The exhaust gas then moves along with the air/fuel mixture, into the combustion chamber. If too much exhaust gas enters, combustion will not occur. Because of this, very little exhaust gas is allowed to pass through the valve. The EGR valve will open once the engine reaches normal operating conditions and

above idle speed. The EGR system is turned off on vehicles equipped with transmission converter clutch (TCC) when the TCC is on. The EGR system may or may not be tied in with the ECM. There are three basic types of systems.

### Ported EGR Valve

This valve is controlled by a flexible diaphragm. It is spring loaded in order to hold the valve closed. When ported vacuum is applied to the top side of the diaphragm, spring pressure is overcome and the valve in the exhaust gas port is opened. This allows the exhaust gas to be pulled into the intake manifold and enter the cylinders for combustion.

### Positive Backpressure EGR Valve

An air bleed valve, located inside the EGR valve assembly acts as a vacuum regulator. The bleed valve controls the amount of vacuum in the vacuum chamber by bleeding vacuum to outside air during the open phase of the cycle. When the EGR valve receives enough backpressure through the hollow shaft, it closes the valve. At this point, maximum available vacuum is applied to the diaphragm and the EGR valve opens. If there is a small amount of vacuum or no vacuum in the vacuum chamber such as wide open throttle or at idle, the EGR valve will not open. The valve will also not open with the engine stopped or idling.

### Negative Backpressure EGR Valve

The negative backpressure EGR valve is similar to the positive backpressure EGR valve except that the bleed valve spring is moved from above the diaphragm to below, and the valve is normally closed. The negative backpressure valve varies the amount of exhaust gas flow into the manifold depending on manifold vacuum and variations in exhaust back pressure. The diaphragm on the valve has an internal air bleed hole which is held closed by a small spring when there is no exhaust backpressure. Engine vacuum opens the EGR valve against the pressure of a spring. When manifold vacuum combines with negative exhaust back pressure, the vacuum bleed hole opens and the EGR valve closes. This valve will open if vacuum is applied with the engine not running.

### EGR Valve Identification

Positive backpressure EGR valves will have a "P" stamped on the top side of the valve after the part number. Negative backpressure EGR valves will

have a "N" stamped on the top side of the valve after the part number. Port EGR valves have no identification stamped after the part number.

## Air Injection Reaction System

The AIR system is used to reduce carbon monoxide (CO) and hydrocarbon (HC) exhaust emissions. On cold engine start up, the system will also help to heat up the catalytic converter more quickly. With faster catalytic converter heat up, the exhaust gas burning process is accelerated.

The system incorporates a dual bed converter. It consists of a two way catalyst, which controls HC and CO emissions and a three way catalyst, which controls HC, CO and NO<sub>x</sub> exhaust emissions. Both the two and three way catalyst are encased in one unit. A pipe connects the two converters to allow air to be injected into the second converter. Injected air into the second converter, helps to increase the CO and HC burning process. The system may or may not be controlled by the ECM.

### Operation Without ECM

A belt driven air pump supplies compressed air through a centrifugal filter fan to a diverter valve. During normal operation, this valve allows air to go to the exhaust manifolds or ports. At high engine speeds, air directed to the air cleaner/silencer. During engine deceleration, when there is a rise in the manifold vacuum signal, air is directed to the air cleaner/silencer.

The system is equipped with check valves, which prevents the back flow of exhaust gases into the air pump in the event of an exhaust backfire or pump drive belt failure.

### Operation With ECM

A belt driven air pump supplies air through a centrifugal filter fan to the electric air control valve. This valve directs the air to either the engine exhaust manifold ports or to the air cleaner. When the engine is cold or in the wide open throttle position, the ECM energizes the solenoid on the valve and air is directed to the exhaust manifold ports.

As the coolant temperature increases, the solenoid is de-energized and air goes into the air cleaner which also acts as a silencer. At higher engine speeds, air is directed to the air cleaner through a pressure relief valve even though the solenoid may be energized.

During engine deceleration, when there is a rise in the manifold vacuum signal, air is directed to the air cleaner.



A check valve on either side of the engine prevents back flow of exhaust gases into the air pump if there is an exhaust backfire or pump drive belt failure.

## Air Pump Operation

The air injection reaction system is controlled by an air pump, check valve, a control valve and the necessary tubing. The belt driven air pump, located on the front of the engine, supplies air to the system. A centrifugal fan at the front of the pump, separates any foreign material from the air to be injected. Air then flows from the pump through the control valve, which is ECM controlled, to the check valve. The check valve will prevent any back flow of exhaust gases into the pump in the event of pump drive belt failure or vehicle backfire.

## Computer Command Control System

The computer command control system is used to control emissions by close regulation of the air/fuel ratio and by the use of a three way catalytic converter which lowers the level of oxides of nitrogen, hydrocarbons and carbon monoxide.

The major components are an exhaust gas oxygen sensor, an electronic control module, an electronically controlled air/fuel ratio carburetor and a three way catalytic converter.

In order to maintain good idle and driveability under all driving conditions input signals are used to modify the computer output signal. These input signals are supplied by the engine temperature sensor, the vacuum control switches, the throttle position switch, the map sensor and the barometric pressure sensor.

## MAJOR COMPONENTS AND OPERATION

### Electronic Control Module

The electronic control module monitors the voltage output of the oxygen sensor along with information from other input signals. This is done to generate a control signal to the carburetor solenoid assembly. This control signal is continually cycling the solenoid between on, which is lean command, and off, which is rich command. When the solenoid is energized it pulls down a metering rod which reduces fuel flow. When the solenoid is deenergized the spring loaded metering rod returns to the up position and fuel flow increases. The amount of time that this assembly functions is

based on input voltage from the oxygen sensor.

On some engines the electronic control module also controls the electronic spark control timing system and the electronic module retard system. This system has the capability to retard the engine timing ten degrees during certain engine operations. During other engine operations the module functions the same as the regular HEI module. The "R" terminal on the module is connected to the electronic control module and the retard function is accomplished by an internal ground. The timing retard is ten degrees only when the engine coolant temperature is between 66 degrees F. and 130 degrees F. and with the throttle opening position below 45 percent and engine speed above 400 rpm.

## TACHOMETER SIGNAL TO COMPUTER

The computer monitors the engine crankshaft position signal in order to determine engine rpm. This signal is generated as a pulse from the HEI distributor. The tachometer signal comes from the tach terminal of the distributor. A tachometer signal filter is located between the distributor and the computer in order to reduce interference from the radio. A tachometer cannot be connected in line between the tach filter and the computer, if it is the computer may not receive the tach signal. The presence of the tach signal from the distributor can be determined by connecting a tachometer to the distributor tach terminal.

## ENGINE COOLANT SENSOR

The engine coolant temperature sensor, which is located in the engine block, sends the electronic control module information on engine temperature. This information can be used to vary the air/fuel ratio as the coolant temperature varies with time during a cold start. It also accomplishes various switching functions at different temperatures and provides a switch point for hot temperature light indication and spark advance.

This sensor has a connector which allows the ground return lead to surround the signal lead. This design provides an interference shield to prevent high voltage in the spark plug wires from affecting the sensor signal to the computer.

## EXHAUST OXYGEN SENSOR

The oxygen sensor is located in the exhaust manifold. Its function is to compare oxygen content in the exhaust

stream to the oxygen content in the outside air. This shows that there is a passage from the top of the oxygen sensor to the inner chamber that allows outside air to enter the system. When servicing the sensor do not plug or restrict this chamber.

A rich exhaust stream is low in oxygen content and will cause the sensor to send a rich signal of about one volt to the computer. A lean exhaust stream will result in a lean signal of less than half a volt being sent to the computer.

As the sensor temperature increases during engine warm up the sensor voltage also increases. Because of the minimum voltage required to operate is half a volt the computer will not use the oxygen sensor signal until the temperature reaches about 600 ° F. to operate the sensor

## THROTTLE POSITION SENSOR

This sensor is located in the carburetor body and is actuated by the accelerator pump lever. The stem of the sensor projects up through the air horn, contacting the underside of the lever. As the throttle valves are opened, the pump lever presses down proportionately on the sensor, thus indicating throttle position.

The throttle position sensor changes the voltage in circuit E (reference voltage) to G (voltage input to the computer) as the sensor shaft moves up or down. This is similar to the operation of the gas tank gauge sending unit, except that the throttle position sensor permits the computer to read throttle position.

## BAROMETRIC PRESSURE SENSOR

The barometric pressure sensor provides a voltage to the computer to allow ambient pressure compensation of the controlled functions. This unit senses ambient barometric pressure and provides information to the computer on atmospheric pressure changes due to weather and/or altitude. The computer uses this information to adjust the air/fuel ratio. The sensor is mounted under the instrument panel near the right hand air condition outlet and is electronically connected to the computer. The atmospheric opening is covered by a foam filter.

## MIXTURE CONTROL SOLENOID

The mixture control solenoid actuates two spring loaded rods that control



# 1 CHEVROLET/GMC

fuel flow to the idle and main metering circuits of the carburetor. Energizing the solenoid lowers the metering rod into the main metering jet. This makes the air-fuel mixture in the carburetor leaner. The Varajet carburetor has a solenoid operated fuel control valve.

The mixture control solenoid changes the air/fuel ratio by allowing more or less fuel to flow through the carburetor. When no electrical signal is applied to the solenoid, maximum fuel flows to the idle and main metering circuits. When an electrical signal is applied to the solenoid, the mixture is leaned.

## COMPUTER COMMAND CONTROL SYSTEM CARBURETORS

Three types of Rochester carburetors are used for system applications. The Varajet is a two barrel, staged opening carburetor. The Quadrajete is a four barrel nonstaged carburetor, essentially the primary side of a Quadrajete. The metering rods and an idle bleed valve are connected to a 12 volt mixture control solenoid. The model E2SE carburetor, used with the computer command control system, is a controlled air/fuel ratio carburetor of a two barrel, two stage down draft design with the primary bore smaller in size than the secondary bore. Air/fuel ratio control is accomplished with a solenoid controlled on/off fuel valve which supplements the preset flow of fuel which supplies the idle and main metering systems. The solenoid on/off cycle is controlled by a 12 volt signal from the computer. The solenoid also controls the amount of air bled into the idle system. The air bleed valve and fuel control valve work together so that the fuel valve is closed when the air bleed valve is open, resulting in a leaner air/fuel mixture. Enrichment occurs when the fuel valve is opened and air bleed valve closed.

The Quadrajete Dualjet arrangement is such that the level of metering is dependent on the positioning of rods in the orifices. The Varajet system is different in that it features a non-moving part main system for lean mixtures and a supplemental system to provide for rich mixture.

## AIR FLOW CONTROL SYSTEMS

Two types of air systems are used on computer command control engines, the pulse air injection reactor (PAIR) and the belt drive air pump (AIR). Both types are controlled by the computer through solenoid valves. The

PAIR system uses an on/off solenoid which is open during cold operation and wide open throttle (WOT). Air is injected into the exhaust ports when the solenoid valves are open.

## AIR MANAGEMENT SYSTEM

The computer controlled solenoid can divert air during any desired operating mode. The valves diverting the switching the air flow are the air diverter valve and the air select valve. With the air divert valve, a rapid increase of engine manifold vacuum diverts air to the air cleaner and high air system pressure is diverted to the air cleaner. The air select valve switches air between the catalytic converter and exhaust ports.

## DISTRIBUTOR HEI MODULE

The computer will control the module above 200 rpm by applying a voltage to the bypass line and signaling terminal E. Current loss at terminals R or B will cause the distributor (HEI) module to take over. Loss of terminal E electronic spark timing will cause the engine to stop assuming bypass voltage is present. If the engine is equipped with electronic spark control, the computer electronic spark timing line would go to the electronic spark control distributor. The electronic spark control delay output would go to the HEI electronic spark timing input.

## ELECTRONIC SPARK TIMING

Electronic spark timing is a computer controlled system that has all the engine spark timing information stored in memory. At various engine operating conditions as determined by rpm and manifold pressure, the system determines the proper spark advance. It then produces the firing signal at the desired crankshaft position. Other parameters, such as coolant temperature and barometric pressure, can be sensed and this information used to modify, as appropriate, the spark advance number from the table. The system provides a much more flexible and accurate spark timing control than the conventional centrifugal and vacuum advance mechanisms in the distributor.

## VACUUM SENSORS

The vacuum sensors measure changes in manifold pressure and provides this information to the ECM. The pressure changes reflect need for adjustments in air/fuel mixture, spark timing (EST) and other controlled operations

to maintain good vehicle performance under various driving conditions.

## VEHICLE SPEED SENSORS

The vehicle speed sensor is mounted behind the speedometer in the instrument cluster. It provides a series of pulses to the ECM which are used to determine vehicle speed.

## Closed Loop Emissions System

The closed loop emission control system consists of an Air Injection Reactor (AIR) System, (ECM controlled), an Exhaust Gas Recirculation (EGR) System, a Thermostatically Controlled Air (TCA) Induction System, a Positive Crankcase Ventilation (PCV) System, an Evaporative Emission Control system (ECS) and a Closed Loop emission control system.

The closed loop emission control is a system that precisely controls the air/fuel ratio near a balanced point that allows the use of a three way catalyst to reduce oxides of nitrogen and oxidize hydrocarbons and carbon monoxide. The essential components are an exhaust gas oxygen sensor, and electric control module (ECM), a vacuum controller with duty solenoid, a control air fuel ratio carburetor and a three way catalytic converter. The closed loop emission control system is an electronically controlled exhaust emissions system. The major components are, an oxygen sensor, and electronic control module, a vacuum controller and catalytic converter.

This system features a CHECK ENGINE fault lamp on the instrument panel which will light in case of a system malfunction and will remain illuminated as long as the engine runs with the malfunction uncorrected. This same lamp, through an integral diagnostic system, will aid a technician in locating the cause of the light.

## OXYGEN SENSOR

The oxygen sensor used in the closed loop control system consists of a closed end zirconia sensor placed in the engine exhaust gas stream. This sensor is mounted in the exhaust manifold. The sensor generates a voltage which varies with the oxygen content in the exhaust gas stream. As oxygen content rises, (lean mixture) voltage falls, and as oxygen content falls, (rich mixture) voltage rises.

## ELECTRONIC CONTROL MODULE

The ECM generates a control signal to the vacuum controller solenoid which

controls carburetor air /fuel ratio through vacuum signals. This control signal is continuously cycling the solenoid between on and off time as a function of the input voltages from the sensors. The control signal generated by the ECM is selected from four operational modes. Mode number one is, no signal to vacuum controller solenoid. Mode number two is enrichment mode A is a fixed preprogrammed duty cycle to vacuum controlled solenoid. Mode number three open loop mode, which is a fixed preprogrammed duty cycle to vacuum controller. Mode number four closed loop mode, which is a calculated duty cycle, is generated based on oxygen sensor and other sensor outputs. During closed loop operation, the ECM monitors the voltage output of the oxygen sensor. When the exhaust is lean, the oxygen sensor voltage is low and the ECM commands a richer mixture. When the exhaust is rich, the oxygen sensor voltage is higher and the ECM commands a leaner mixture.

The ECM also stores in memory the current duty cycle being used for either idle or off idle condition. When the ECM sees a change from idle condition (as signaled by the vacuum switch) to off idle condition, it immediately steps to the duty cycle last recorded for optimum operation. From then on, while at that engine operating condition, the system uses the basic controls as previously described.

The ECM sends a signal to control the slow cut solenoid valve incorporated in the carburetor. The ECM senses the coasting condition by means of the signals from the transmission gear position, clutch pedal position switch and idle position switch, it opens the circuit to the slow cut solenoid valve when the engine speed is above the speed specified, causing the fuel flow to the carburetor to be shut down. The circuit to the slow cut solenoid valve is cut off only at the time when the following four conditions exist simultaneously. Condition one, the transmission is not in neutral position (M/T), or in either neutral or park position (A/T). Condition two, the clutch is engaged (M/T). Condition three, the accelerator is at idle position. Condition four, the engine speed exceeds the limit of the specified speed.

## VACUUM CONTROLLER

The vacuum controller converts the electrical signals from the electronic control module into vacuum signals by means of the vacuum control solenoid. The vacuum signals operate the fuel control actuators in the carburetor, thereby controlling the air/fuel ratios. This vacuum controller consists of a

vacuum regulator and a vacuum control solenoid. The vacuum regulator regulates the inconstant vacuum from the intake manifold to the constant vacuum needed to control the actuators. The vacuum control solenoid, controlled by the ECM, uses the vacuum from the vacuum regulator to operate the fuel control actuators in the carburetor.

## TEMPERATURE SWITCH

The temperature switch is a bimetal disc snap action type and this switch sends engine coolant temperature information to the ECM. This temperature information is used as one of the inputs to determine when the system is ready to enter the closed loop mode of operation. The information from this switch is also used as the inputs to determine the secondary air injection.

## CATALYTIC CONVERTER

The three way catalytic converter reduces oxides of nitrogen which oxidizes hydrocarbons and carbon monoxide. To maintain high conversion efficiency, it is necessary to closely control the air fuel ratio near 14.7 to 1.

## TROUBLE DIAGNOSIS

The closed loop emission control system has a self diagnostic system. When there is an indication of a fault in the system, a CHECK ENGINE lamp on the instrument panel will remain on when the engine is running.

The system requires the following tools and equipment in order to diagnosis and repair any malfunctions that may occur. A tachometer, either a crankshaft harmonic balance revolution pickup type of electronic coil trigger signal pickup type. A dwellmeter that is used to indicate the performance conditions of the idle or off idle circuit. Connect the positive lead of dwellmeter to the bright green connector in the wiring harness and the negative lead to ground. Place a meter on four cylinder scale. The scale on the meter will show the change from idle condition to off idle condition. A vacuum gauge which is used to monitor manifold engine vacuum. A vacuum pump which is used to check pressure or vacuum sensors and vacuum operated valves. A voltmeter and ohmmeter which must be digital to measure voltage and ohm for circuits. A set of jumper wires to bypass a circuit and to insert between special connectors to permit access to the connector terminals for circuit checking. A test light and various connector tools or tool J-28742 for the removal of terminals on weather pack connectors.

## ACTIVATING DIAGNOSTICS

1. Start engine.
2. Locate diagnostic terminal tape on system harness near ECM.
3. Connect terminals together and note CHECK ENGINE light.
4. If a trouble code is stored in system the light will begin to flash a two digit code.
5. An example is Code 24. To indicate this code the light would flash twice and there would be a short pause and then it would flash four times, then there will be a longer pause and this code would repeat three times.
6. If there is more than one trouble code stored, the system starts with the lowest code number followed by the next highest code number. The next higher code will flash three times and if there are no additional codes, the system will repeat the cycle.

## EGR Valve

### REMOVAL & INSTALLATION

1. Disconnect EGR pipe from adaptor. Disconnect EGR valve vacuum hose at valve.
2. Remove bolts holding EGR valve on manifold adaptor and remove valve.
3. Clean EGR mounting surface. Install replacement EGR valve using new gasket. Connect EGR pipe.

## Back Pressure Transducer

### REMOVAL & INSTALLATION

1. Remove back pressure transducer from clamp bracket.
2. Remove hoses from transducer.
3. Reverse procedure to install transducer.

## EFE Heater

### REMOVAL & INSTALLATION

1. Remove air cleaner. Disconnect all electrical, vacuum, and fuel connections from carburetor.
2. Disconnect EFE Heater electrical connector. Remove carburetor. Replace EFI heater insulator assembly.
3. Reinstall carburetor. Reconnect EFI Heater electrical connection.
4. Reconnect electrical, vacuum and fuel connections to carburetor. Replace air cleaner. Start engine and check for vacuum leaks.



## EFE Temperature Switch

### REMOVAL & INSTALLATION

1. Drain coolant below level of engine coolant outlet housing.
2. Disconnect electrical connector. Remove the switch.
3. Apply a soft setting sealant uniformly on replacement switch threads. No sealant should be applied to sensor of switch.
4. Install switch and tighten to 10 ft. lbs. Connect electrical connector. Add coolant as required.

## EFE Relay

### REMOVAL & INSTALLATION

1. Disconnect battery ground. Disconnect electrical connector at relay.
2. Remove bolts holding relay and remove relay.
3. Installation is the reverse of the removal procedure.

## Air Injection Pump

### REMOVAL & INSTALLATION

1. Remove air pump drive belt from air pump pulley.
2. Disconnect hose from air switching valve.
3. Remove attaching bolts from engine mount and jack up mount.
4. Remove air pump mounting bolts and remove air pump and air switching valve.
5. Remove air switching valve from air pump.
6. Reverse procedure to install.

## Air Switching Valve

### REMOVAL & INSTALLATION

If the air switching valve is normal, the secondary continues to blow out from the valve for a few seconds when the accelerator pedal is depressed all the way to the floor and released quickly. If the secondary air continues to blow out for more than 5 seconds, replace air switching valve. Remove hoses from air switching valve. Remove mounting hardware and remove valve. Reverse procedure to install.

## Check Valve

### REMOVAL & INSTALLATION

1. Release clamp and disconnect air hose from check valve.

2. Unscrew check valve from air injection pipe.
3. Reverse procedure to install.

## Vacuum Switching Valve

### REMOVAL & INSTALLATION

1. Disconnect electrical connector.
2. Remove hoses from valve.
3. Remove vacuum switching valve.
4. Reverse procedure to install valve.

## Electronic Control Module

### REMOVAL & INSTALLATION

The ECM is located on the passenger side, under the instrument panel. Do not replace the ECM unless diagnostic procedures have determined it to be malfunctioning.

## Temperature Switch

### REMOVAL & INSTALLATION

1. Disconnect electrical connection at temperature switch.
2. Remove temperature switch.
3. Install switch and tighten to 72 inch lbs.
4. Connect electrical connector.

## Vacuum Controller

### REMOVAL & INSTALLATION

1. Disconnect electrical connector.
2. Disconnect vacuum hoses from vacuum regulator and solenoid.
3. Remove vacuum controller.
4. Reverse procedure for installation.

## Idle And WOT Vacuum Switch

### REMOVAL & INSTALLATION

1. Disconnect electrical connector.
2. Disconnect vacuum hoses from sensors.
3. Remove idle and WOT vacuum switch.
4. Reverse procedure for installation.

## Oxygen Sensor

**NOTE: Oxygen sensor uses a permanently attached pigtail and connector. This pigtail should not**

**be removed from the oxygen sensor. Damage or removal of pigtail or connector could affect proper operation of the oxygen sensor. Care must be taken when handling an oxygen sensor in order to preserve the efficiency. The inline electrical connector and louvered end must be kept free of grease or other contaminants. Do not use cleaning solvents of any type.**

### REMOVAL & INSTALLATION

Oxygen sensor may be difficult to remove when engine temperature is below 120°F. Excessive force may damage threads on exhaust manifold or exhaust pipe. Disconnect electrical connector and any attaching hardware. Remove oxygen sensor. A new oxygen sensor is pre-coated with antiseize compound, but if same oxygen sensor is being installed, coat threads of oxygen sensor with antiseize compound P/N 5613695, or equivalent. Install the sensor and torque to 30 ft. lbs.

## ENGINE MECHANICAL

Refer to the Unit Overhaul Section for Overhaul Procedures.

## S-Series Engines

### REMOVAL & INSTALLATION

**119 CID (1.9L) and 151 CID (2.5L) Engines**

1. Disconnect the negative battery cable. Matchmark and remove the hood. Drain the cooling system. Disconnect and plug the transmission oil cooler lines, if equipped.
2. Remove the air cleaner assembly and vacuum hoses. Mark the vacuum hoses for reinstallation. Remove the air condition compressor and position it to the side, if equipped.
3. Disconnect all hoses, tubing and electrical leads from the engine and mark them for reinstallation. Remove the power steering pump, if equipped and lay aside.
4. Remove the radiator. Remove the fan assembly. Disconnect the exhaust pipe from the exhaust manifold. Disconnect the oxygen sensor wire. Properly relieve the fuel pump pressure. Disconnect and plug the fuel line hoses.
5. Raise the vehicle and support it safely. Drain the engine oil.